_vKi construction

How 25 design choices contribute to dynamic performance

Purpose of the document

A _vKi driver is not defined by one visible feature.

Its performance comes from a coherent and innovative set of construction details: frame design, surround behavior, cone material and geometry, voice coil, spider and motor architecture.

Setting a new state of the art requires moving away from existing parts supplied by loudspeaker component suppliers.

Every single part of the _vKi transducer has been engineered, tooled and produced by Kartesian.

FRAME

1- More useful radiating area

Reduced surround landing increases the active diameter by 16 to 20 mm. On a 7-inch woofer, this represents around +20% active radiating area without changing the nominal size.

This assembly requires a more accurate gluing operation than a standard surround landing, but it increases Sd [cm²] for an unchanged frame diameter.

2- Balanced mechanical structure

Frame geometry balances the mechanical path between the voice coil, spider and surround.
This feature improves the stability of the moving parts under large excursion.

3- Fully vented – More rigid

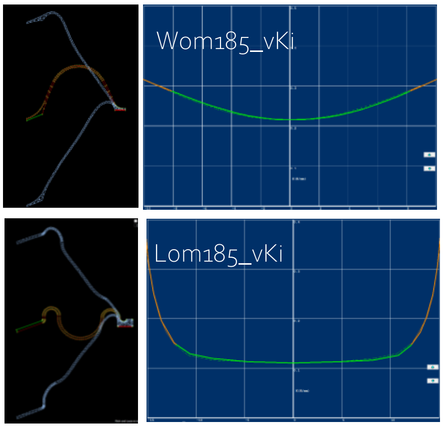
The _vKi frames are engineered to be widely open and vented, while rigidity is improved.
Frame geometry has been developed using CAD modelling with the aim of avoiding any airflow noise, while remaining a perfect mechanical reference under all conditions.

SURROUND

4- Low-loss material

Specific NBR or IIR rubber, typically 45° to 60° Shore, is softer than usual rubber surrounds.

Lower mechanical losses help maintain higher Qms and cleaner transient behavior.

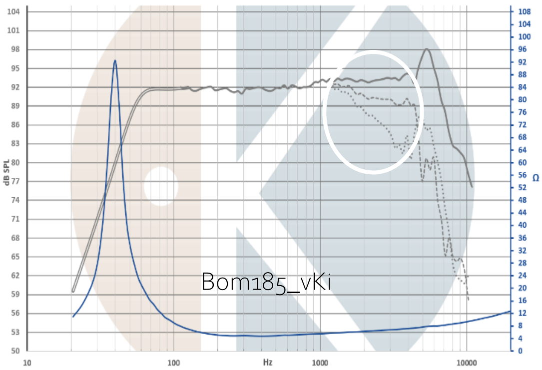


5- Linear behavior

Symmetric surround stiffness significantly reduces low-frequency THD and supports stable large-excursion behavior.

This linear and symmetric compliance around the rest position is ensured whatever the surround geometry of the _vKi driver.

Half-roll, Omega-profile and "M"-shaped surrounds have been optimized using FEA simulation to reach the best possible result.



6- Low diffraction profile

The innovative omega profile reduces surround diffraction.

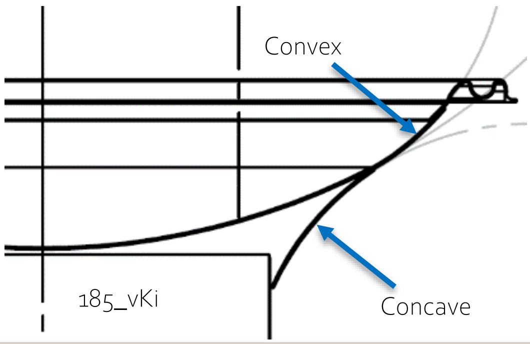
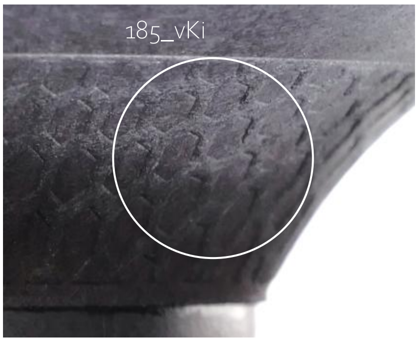
More controlled off-axis behavior simplifies crossover design with the tweeter.

This feature is also interesting for building coaxial versions, which is possible through OEM/ODM collaboration.

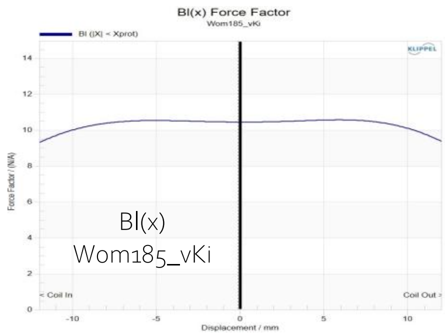
7- Surround reinforcement

Specific reinforcement in the surround or on its back ensures an ideal mechanical transition with the cone.
This feature avoids the typical resonance around 1 kHz, usually visible as a peak on the impedance curve.

MEMBRANE

	**8- Cone geometry** Cone geometry is a key engineering point for managing the frequency response, including off-axis behavior. On the 185 series, the cone uses an innovative concave/convex profile, providing higher rigidity over a wide bandwidth compared with usual conical or exponential profiles.
	**9- Cone materials** Kartesian has developed cone materials to control the loudspeaker response not only in the frequency domain, but also in the time domain, to avoid lagging and improve sound clarity and intelligibility. These materials include: - CGF (glass fiber + carbon fiber + damping) - hexaKone (paper + Kevlar + cotton + embossed structure) - ARR (aluminum ring with damping)
	**10- Cone venting** The moving parts (voice coil, membrane, spider and surround) are fully vented to avoid any internal resonance that could create sound coloration. Venting is everywhere: through the motor structure, the frame, the voice coil former and the cone. Every internal cavity has been removed.
	**11- Inner damping** To avoid sound reflection from the back of the cone onto the motor structure, even though it is widely open, we added damping foam. This is usually used on tweeters to absorb the back wave of the dome, but at the _vKi performance level, it becomes relevant to address this point.

VOICE COIL

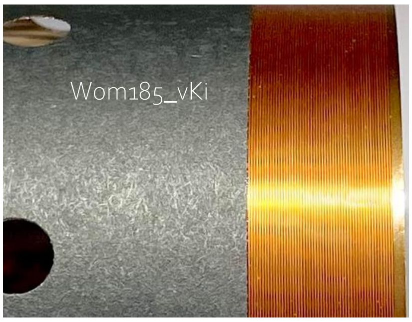


12- Under-hung – Constant Bl(x)

The underhung voice coil design is the ideal solution for linear and accurate loudspeaker cone motion.

Every single _vKi reference, from mid-woofer to subwoofer, uses an underhung topology: a very short coil in a very long magnetic field.

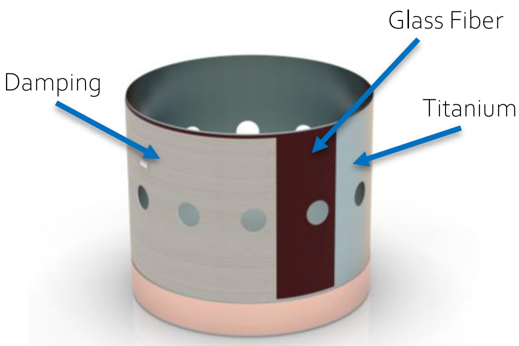
The result is a very wide, symmetric and linear force factor, ensuring accurate signal reproduction even under large cone excursion.



13- Low inductance – Low mass

Thanks to its powerful motor structure, the _vKi voice coils can be built with only one layer, providing several advantages:

- Very low inductance, typically three times lower than competitors
- Very low mass (the coil is an important part of Mms [g])
- Excellent thermal dissipation (lower long-term power compression)



14- Damped Titanium

Voice coil former material has consequences for overall loudspeaker performance: electrical damping, mechanical damping, voice coil thermal management and frequency response.

Titanium is an excellent choice, but it must be damped to avoid a sound signature, visible in the time domain as lagging.

Every single _vKi voice coil is built on a titanium former, reinforced with glass fiber and specifically damped to optimize each reference.

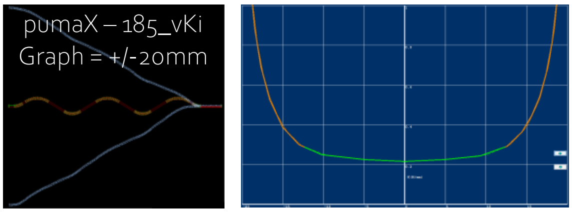
15- Connection to the coil

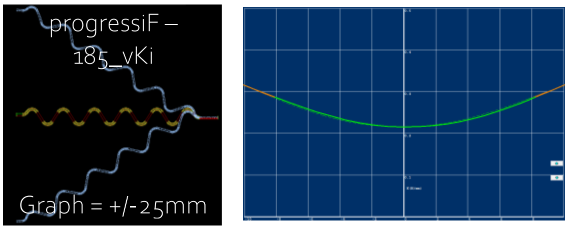
The connection from the speaker terminal, through the lead wire and finally to the coil, cannot be neglected at the _vKi level.

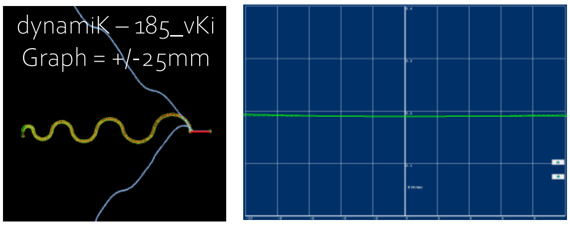
The old-school solution of free wire going through the cone, with a handmade glue point, is never an option for Kartesian drivers.

All _vKi voice coils are connected by a soldering point between the lead wire and the copper pad, providing lower resistance, higher reliability and consistency without any mechanical influence on speaker performance.

SPIDER







16- Controlled stiffness

All spiders used by Kartesian provide symmetric stiffness Kms(x).
This is what should be expected from any high-quality loudspeaker driver.
For _vKi drivers, Kartesian has engineered three spider technologies that go one step further, allowing the stiffness curve to be precisely shaped.

This makes it possible to control both the linear range, where the resonance frequency must remain stable, and the protection area, where stiffness increases to protect the driver from excessive excursion.
These three spider technologies are:
pumaX: Linear stiffness within the useful excursion range, followed by a clear protection area with a significant stiffness increase above it.
progressiF: A smooth U-shaped stiffness profile over the full excursion range, with progressive protection close to the mechanical limit. Useful for smoothing the transition between the linear range and the protection area.
dynamiK: Strictly linear stiffness over the full excursion range. This is the ideal spider to preserve the dynamics of the audio signal, but it does not provide mechanical protection by itself. We recommend using an active limiter, or applying this spider technology only in suitable use cases.

17- Integrated lead wires at 180°

Lead wires can be a weak point in loudspeaker design, which is not acceptable at the _vKi level.

All lead wires ensure the highest conductivity (silver-plated copper), long life and reliability (aramid/Kevlar core).

These lead wires are attached to the spider to avoid any random contact with the back of the cone. They are positioned at 180° to balance their mechanical stiffness.

Spiders 185_vKi

18- Fiber material, density and resin

For every single reference, instead of adjusting spider stiffness by adding resin, as is usually done in the loudspeaker industry, we optimize restoring force capacity and performance reliability by selecting the best material and weaving density, and then adding the suitable resin.

Generally, the less resin used, the better.

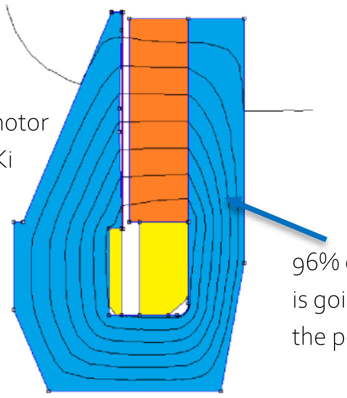
19- Adaptable stiffness profile

By using two spiders, especially for subwoofer references, it is possible to precisely adjust the stiffness curve, keeping constant stiffness over the useful excursion range and a smooth transition up to higher stiffness to protect the driver.

It should be noted that the spider spacer is not a basic cardboard ring. Each spider spacer has been designed to be widely vented and to prevent any cavity between both spiders.

MOTOR STRUCTURE

Cut-view motor 185-265_vKi



96% of the flux is going through the pole piece

20- Thick radial magnets

Radial magnets are very rare in the audio industry because they are expensive to produce, but also because only thin magnets can be manually assembled with a regular magnet charger. Kartesian has developed a specific, innovative and unique magnet charger dedicated to _vKi products.

It makes it possible to use thick magnets and avoid the usual magnetic short circuit at the top and bottom of the magnets.

In _vKi motor design, more than 95% of the magnetic flux goes through the pole piece.

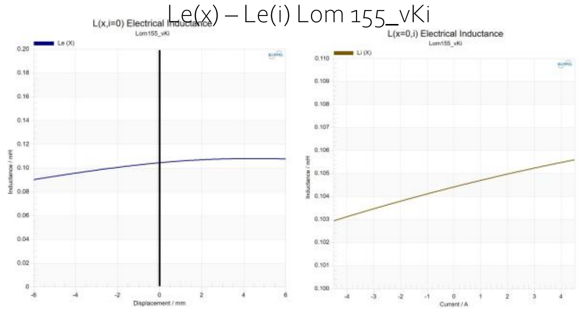
Motor 155_vKi

21- Copper spacer – Back FEM

The _vki motor structure use cooper spacer between magnets in order to manage the back electromagnetic force coming from the coil when the driver is working.

This feature is very important to respect the signal to be reproduced, whatever its amplitude and frequency.

Le(x) – Le(i) Lom 155_vKi



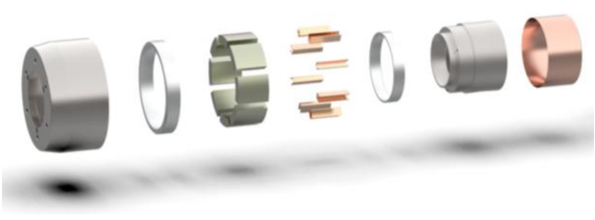
22- Inductance management

Inductance is a key parameter for ensuring the highest dynamic performance in loudspeaker design.

<u>The nominal value must be:</u>

- As low as possible (e.g. Lom155_vKi: 0.08 mH at 1 kHz)
- Constant over the full excursion (e.g. Lom155_vKi: 0.02 mH over +/-6 mm)
- Independent of current (e.g. Lom155_vKi: 0.03 mH over +/-4.5 mm)

Exploded view motor 185-265_vKi

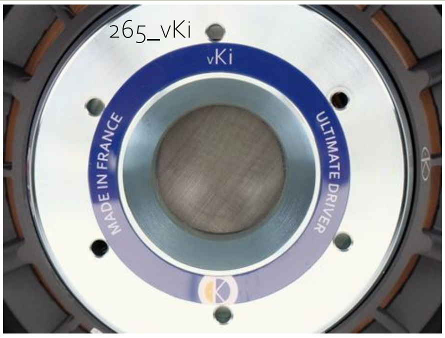


23- Very low hysteresis distortion

The steel in the motor structure generates hysteresis distortion.

This physical problem is mainly observed in the time domain because it acts as "magnetic flux storage" that is released with a short delay. The magnetic field is supposed to remain unchanged to provide suitable acceleration to the voice coil and reproduce the input signal accurately.

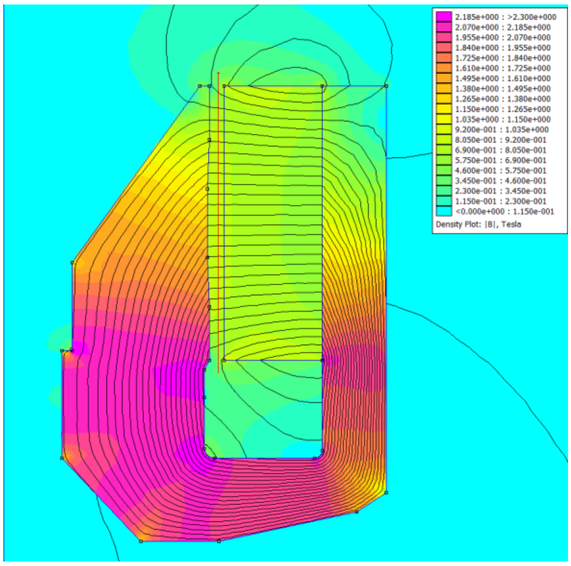
Thanks to the short coil working in a fully demodulated motor architecture, _vKi transducers achieve very low hysteresis distortion.



24- Voice coil cooling

_vKi loudspeakers use large voice coils to increase power handling and reduce thermal compression, but additional specific cooling has been engineered into the motor structure.

Voice coil movement creates airflow through the motor structure to cool the coil. The frame is also used as a thermal dissipater, cooled by the airflow generated by the cone.



25- Powerful magnetic field

_vKi motor structures are exceptionally powerful, especially compared with regular motor designs, whatever the magnet type or grade used.

For example, the 155_vKi motor provides 0.92 T (10% tolerance) over a 44 mm diameter and 30 mm height.

This means 0.92 T over 41.5 cm^2.

A powerful pro-audio woofer, typically 6.5 inches with a 38 mm voice coil, has a magnetic gap height of 5 mm with 1.15 T (large ø110 mm ferrite).

This means 1.15 T over only 6 cm^2.

<u>Let's compare the total magnetic flux: $\Phi = B \times S$</u>

- 155_vKi has Φ = 3.82 mWb
- The pro-audio competitor has Φ = 0.69 mWb

➔ _vKi provides magnetic flux 5.5 times higher than the pro-audio woofer.

<u>It should be noted:</u>

- The _vKi motor is 2 times lighter.
- The _vKi motor is 2 times more compact.
- The excursion capability of _vKi is 3 times larger.
- The inductance of _vKi is 8 times lower.

The comparison is stark, but the differences with _vKi are factual.

Conclusion

Considering these construction details and their combined effect on measured performance, _vKi should not be understood as a conventional driver architecture with incremental improvements, but as a coherent technology platform dedicated to high dynamic capacity.

_vKi is one of the most advanced loudspeaker driver platforms for brands looking to reach a higher level of dynamic performance.